

CLAIMS

What is claimed is:

1. A method of tracking data transmitted from a source device to a receiving device over a communication medium, comprising:
 - receiving a data packet;
 - reading a first sequence number from the received data packet;
 - determining whether the first sequence number is contiguous with a sequence number range contained in a first preexisting node of a tree data structure, wherein the tree data structure is stored in a memory coupled to the receiving device;
 - if the new sequence number is not contiguous with the sequence number range, creating a new node that contains the new sequence number; and
 - if the new sequence number is contiguous with the sequence number range, updating the first preexisting node such that the new sequence number becomes a new boundary value for the sequence number range contained in the first preexisting node.
2. The method of claim 1 wherein said new and first preexisting nodes each comprise:
 - a lower boundary field for storing a minimum value of a contiguous range of sequence numbers;
 - an upper boundary field for storing a maximum value of the contiguous range;
 - a left pointer field for storing a value that identifies an adjacent node containing a lower contiguous range of sequence numbers; and
 - a right pointer field for storing a value that identifies another adjacent node containing a higher contiguous range of sequence numbers.
3. The method of claim 1 further comprising:
 - determining if the first preexisting node, after it has been updated, contains a sequence number range that is contiguous with a sequence number range of a second preexisting node; and
 - if the sequence number range contained in the first preexisting node, after it has been updated, is contiguous with the sequence number range of the second preexisting node, merging the first and second preexisting nodes into a single node that represents a new

contiguous range that includes the previous ranges represented by the first and second preexisting nodes prior to their merger.

4. The method of claim 3 further comprising:
determining if said data packet is a last packet of a data set;
if said data packet is a last packet of a data set, determining whether all packets have been received; and

wherein if the data packet is the last packet and all packets of the data set have not been received, sending a SNACK message to said source device, indicating which packets are missing.

5. The method of claim 1 wherein said communication medium is a computer network communications medium and said sequence numbers are iSCSI sequence numbers.

6. The method of claim 1 further comprising:
determining whether the number of nodes of said tree data structure exceeds a predetermined maximum value N; and
terminating a communication channel between said source device and said receiving device if the number of nodes exceeds N.

7. A method of tracking data transmitted from a source device to a receiving device over a communication medium, comprising:
receiving a data packet
reading a new sequence number from the received data packet;
determining whether the new sequence number is contiguous with a sequence number range contained in a first preexisting node of a binary tree stored in a memory coupled to the receiving device;
if the new sequence number is not contiguous with the sequence number range, creating a new node that contains the new sequence number;
if the new sequence number is contiguous with the sequence number range, updating the first preexisting node such that the new sequence number becomes a new boundary value for said sequence number range contained in the first preexisting node;
determining if the first preexisting node, after it has been updated, contains a sequence number range that is contiguous with a sequence number range of a second preexisting node; and

if the sequence number range of the first preexisting node, after it has been updated, is contiguous with the sequence number range of the second preexisting node, merging the first and second preexisting nodes into a single node that contains a new contiguous range that includes the previous ranges represented by the first and second preexisting nodes prior to their merger.

8. The method of claim 7 wherein said new node and said first and second preexisting nodes each comprise:

a lower boundary field for storing a minimum value of a contiguous range of sequence numbers;

an upper boundary field for storing a maximum value of the contiguous range;

a left pointer field for storing a value that identifies an adjacent node containing a lower contiguous range of sequence numbers; and

a right pointer field for storing a value that identifies another adjacent node containing a higher contiguous range of sequence numbers.

9. The method of claim 8 further comprising:

determining if a last packet of a data set has been received;

if the last packet has been received, determining whether all packets have been received; and

wherein if the last packet has been received and all packets have not been received, sending a SNACK message to said source device, indicating which packets are missing.

10. The method of claim 7 wherein said communication medium is a computer network communications medium and said sequence numbers are iSCSI sequence numbers.

11. The method of claim 7 further comprising:

determining whether the number of nodes of said tree data structure exceeds a predetermined maximum value N; and

terminating a communication channel between said source device and said receiving device if the number of nodes exceeds N.

12. A computer-based system for tracking data transmitted from a source device to a receiving device over a communication medium, comprising:

means for reading a new sequence number from a newly received data packet;

means for determining whether the new sequence number is contiguous with a

sequence number range contained in a first preexisting node of a tree data structure stored in a memory coupled to the receiving device;

means for creating a new node that contains the new sequence number if the new sequence number is not contiguous with the previous sequence number; and

means for updating the first preexisting node such that the new sequence number becomes a new boundary value for the sequence number range contained in preexisting node if the new sequence number is contiguous with the sequence number range.

13. The system of claim 12 wherein said new and first preexisting nodes each comprise:

a lower boundary field for storing a minimum value of a contiguous range of sequence numbers;

an upper boundary field for storing a maximum value of the contiguous range;

a left pointer field for storing a value that identifies an adjacent node containing a lower contiguous range of sequence numbers; and

a right pointer field for storing a value that identifies another adjacent node containing a higher contiguous range of sequence numbers.

14. The system of claim 12 further comprising:

means for determining if the first preexisting node, after it has been updated, contains a sequence number range that is contiguous with a sequence number range of a second preexisting node; and

means for merging the first and second preexisting nodes into a single node that represents a new contiguous range that includes the previous ranges represented by the first and second preexisting nodes prior to their merger, if the sequence number range of the first preexisting node, after it has been updated, is contiguous with the sequence number range of the second preexisting node.

15. The system of claim 14 further comprising:

means for determining if a last packet of a data set has been received;

means for determining whether all packets have been received, if the last packet has been received; and

means for sending a SNACK message to said source device, indicating which packets

are missing, if it is determined that the last packet has been received and all packets have not been received.

16. The system of claim 12 wherein said communication medium is a computer network communications medium and said sequence numbers are iSCSI sequence numbers.

17. The system of claim 12 further comprising:

means for determining whether the number of nodes of said tree data structure exceeds a predetermined maximum value N; and

means for terminating a communication channel between said source device and said receiving device if the number of nodes exceeds N.

18. A system for tracking data transmitted from a source device to a receiving device over a communication medium, comprising:

means for receiving a data packet

means for reading a new sequence number from the received data packet;

means for determining whether the new sequence number is contiguous with a sequence number range contained in a first preexisting node of a tree data structure stored in a memory coupled to the receiving device;

means for creating a new node that contains the new sequence number, if the new sequence number is not contiguous with the sequence number range;

means for updating the first preexisting node such that the new sequence number becomes a new boundary value for said sequence number range contained in the first preexisting node, if the new sequence number is contiguous with the sequence number range;

means for determining if the first preexisting node, after it has been updated, contains a sequence number range that is contiguous with a sequence number range of a second preexisting node; and

means for merging the first and second preexisting nodes into a single node that contains a new contiguous range, which includes the previous ranges represented by the first and second preexisting nodes prior to their merger, if the sequence number range of the first preexisting node, after it has been updated, is contiguous with the sequence number range of the second preexisting node.

19. The system of claim 18 wherein said new node and said first and second preexisting nodes each comprise:

a lower boundary field for storing a minimum value of a contiguous range of sequence numbers;

an upper boundary field for storing a maximum value of the contiguous range;

a left pointer field for storing a value that identifies an adjacent node containing a lower contiguous range of sequence numbers; and

a right pointer field for storing a value that identifies another adjacent node containing a higher contiguous range of sequence numbers.

20. The system of claim 18 further comprising:

means for determining if a last packet of a data set has been received;

means for determining whether all packets have been received; and

means for sending a SNACK message to said source device, indicating which packets are missing, if the last packet has been received and all packets have not been received.

21. The system of claim 18 wherein said communication medium is a computer network communications medium and said sequence numbers are iSCSI sequence numbers.

22. The system of claim 18 further comprising:

means for determining whether the number of nodes of said tree data structure exceeds a predetermined maximum value N; and

means for terminating a communication channel between said source device and said receiving device if the number of nodes exceeds N.

23. A computer readable medium having stored thereon a data structure comprising a tree data structure having a plurality of nodes, wherein a first node of the tree data structure further comprises:

a lower boundary field for storing a minimum value of a first contiguous range of numbers;

an upper boundary field for storing a maximum value of the first contiguous range;

a left pointer field for storing a value that identifies a second node containing a lower contiguous range; and

a right pointer field for storing a value that identifies a third node containing a higher contiguous range.

24. The computer readable medium of claim 23 wherein said first node is merged with a second node which contains a second contiguous range that is contiguous with the first

contiguous range contained in the first node such that at least one of said lower and upper boundary fields of the first node is updated so as to reflect a new expanded contiguous range that includes the first and second contiguous ranges.